CoCalc

Karsten Müller[1,2]
[1]*University of Oslo*
[2]*Norwegian water resources and energy directorate*

ABSTRACT: We applied the online workspace CoCalc to develop and assign in-class exercises and home assignments to students. Our intention was to provide an interactive learning experience where we could combine code, data and explanations in one platform that is easy accessible. CoCalc makes it easy to organize course work and track student's progress. We used CoCalc over four terms and two different courses at the Department of Geosciences at UiO to interact with the students.

1 INTRODUCTION

Project "CoCalc" used a service provided at www.cocalc.com (called CoCalc from now on) for teaching students. CoCalc is a virtual online workspace for collaboratively performing calculations when carrying out research, teaching, or authoring/publishing documents (Cocalc, 2022). CoCalc lets the instructor combine text documents, videos, figures, data, models, and live coding. We have used CoCalc in teaching geophysics to students at UiO. E.g., let them do data processing of ground penetrating radar (GPR) data while explaining in text-form and during classes. We have also used CoCalc to run avalanche run-out models in another class. The students are provided with the model and data and can run and tweak the model themselves. The instructor can distribute hand-outs and assignments and follow the progression of the students both live and after hand-in (Figure 1). Both larger assignments and small exercises during class have been conducted. Options for grading are also available within CoCalc but was done in Canvas in this project.

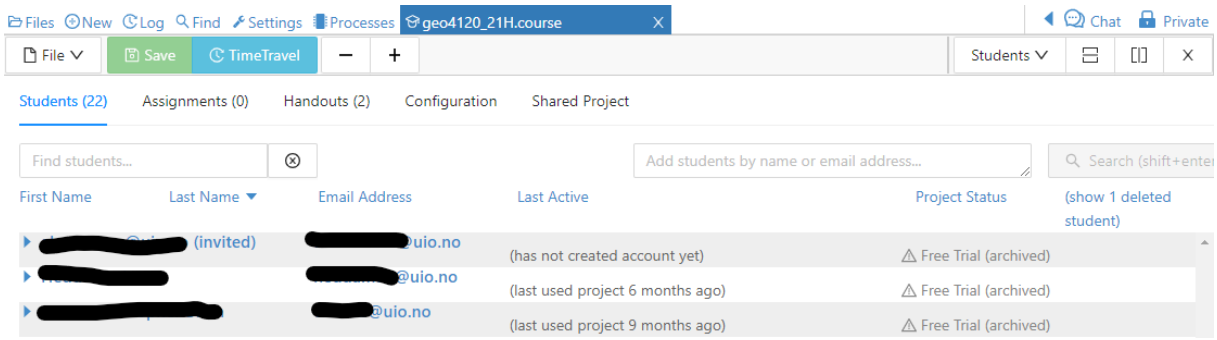

Figure 1: Courses and students are organized in course-files. The teacher can add or remove students and assign licenses. You can also see when students used the project and collaboratively edit a file together with a student. Latter was very useful during the pandemic where meeting physically was rarely possible.

Other features of CoCalc are a collaborative whiteboard, an API, access to a Linux virtual environment and alternative programming languages such as Julia, R, and Octave. However, these features have not been explored during this project. CoCalc is intended to be run in a browser but can also be hosted locally or through a small desktop application on Windows and MacOS.

The aim of this project was to provide an interactive learning environment to students which can be used both online and in-class.

2 COCALC PROJECTS

The main component used for working on CoCalc are Projects. Each project consists of files, accessible only to you and your collaborators, and by creating one or more projects you can partition your work into separate workspaces.

Each file opens in its associated online editor and all work can be conducted directly in a browser without any local set-up or installation. Backup and storing is done automatically and previous versions of a student's work can easily be retrieved. You can edit project files with collaborators simultaneously.

We applied CoCalc in two courses, *GEO4171 – Flood, landslides, and avalanches* and *GEO4120 – Near surface geophysics*.

The teacher demonstrated the exercise or assignment in CoCalc during class including a general introduction to using CoCalc.

CoCalc was used in the avalanche part of GEO4171 to let the students investigate the effect of various snow properties such as snow temperature and density on the cold content of a snowpack. We provided the equations, plots and literature to the students through CoCalc. In another exercise, the students could apply an avalanche run-out model to a slope of the choice. The teacher provided the model code and instructions on how to format and load the necessary topographic data. Students could then choose a relevant place and download topographic data from hoydedata.no and apply and tweak the model.

During the GPR part og GEO4120 we provided GPR data to the students. The notebooks contained exercises that needed to be answered by processing interpretation of the GPR data (Figure 2). The assignment was split into three sections. We went through the first section in class to ensure everybody understood the task and the how to perform it using CoCalc. Sections two and three made up a graded home assignment of GEO4120. Since the processing of GPR data required some computational power, we purchased a licence for each student for 50 days to have access to a suitable computing environment.

We also provided a notebook on Fourier transform to the students of GEO4120. This module was an optional for those who wanted to refresh that topic and was not part of a lecture or exercise. In that sense CoCalc can also be used to provide resources to prepare for class or help students to fill knowledge gaps.

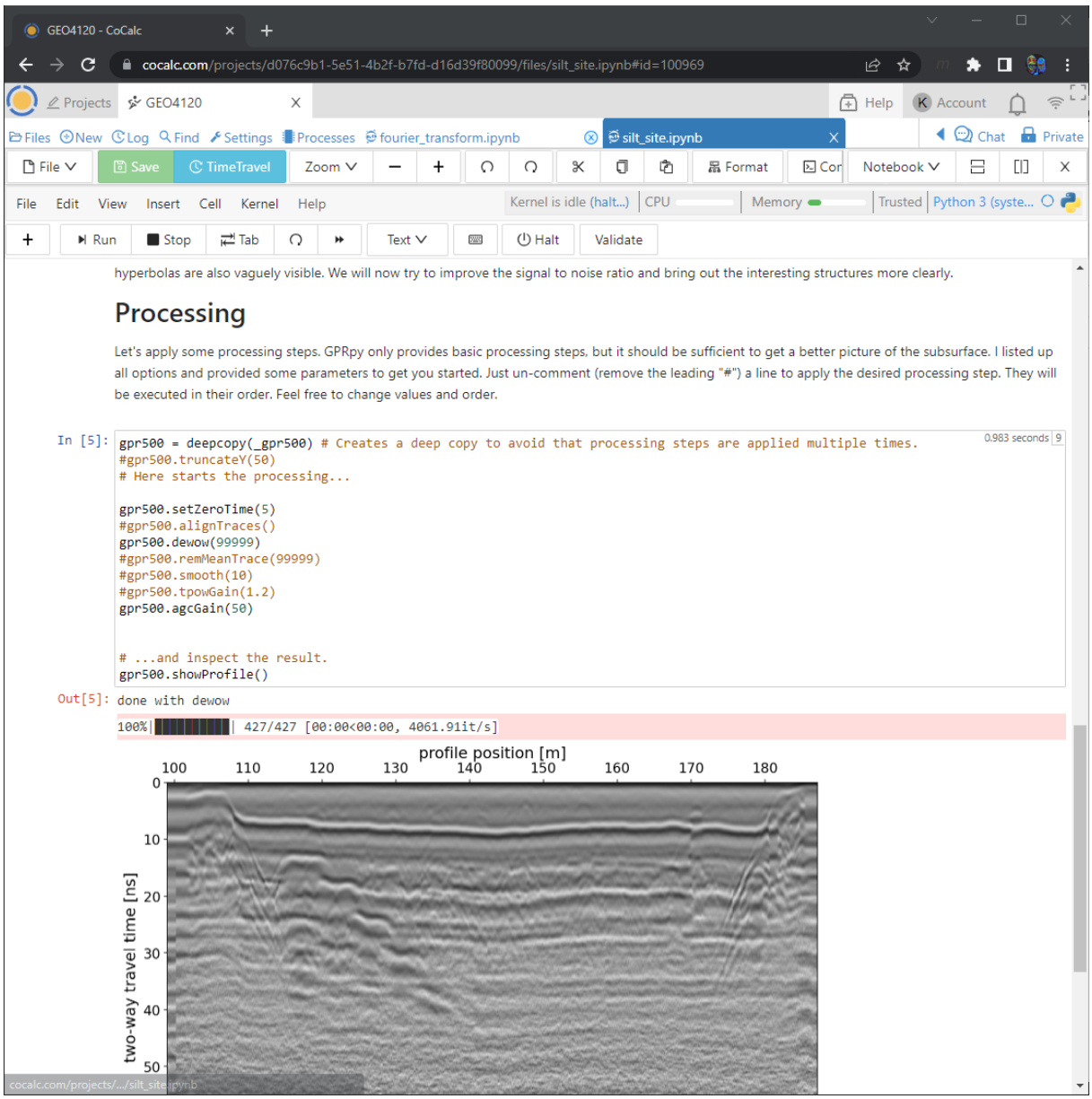

Figure 2: Screenshot showing a GPR processing exercise form course GEO4120 - Near surface geophysics held in autumn 2020 and 2021. In a Jupyter notebook explanatory text and figures can be combined with code snippets and plotting functionality. The more complex scripts can be hidden from the user and run in the background.

3 COSTS

Cocalc is free to use. However, a licence gives access to dedicated servers making the user experience much smoother. Especially during longer exercises. Licenses start at 3$ (~30 NOK) per month per student. During the project period we have purchased a monthly licence for the instructor in order to prepare and edit the student material. We purchased student licenses for a period of about two month for a longer and computing intensive exercise. Most in-class exercises were possible using the free version.

4 DISCUSSION

We used the service provided at www.cocalc.com over four semesters to teach students about GPR applications and avalanche models in two separate courses. It was straight forward to set-up Jupyter notebooks and upload related data and Python scripts. Setting up a course and adding licenses to students allows from term to term or different courses makes it easy to keep personal information separate form data and files that can be reused or shared over different terms or courses.

CoCalc makes it easy to develop, run and distribute Jupyter notebook and related files online. It also makes it easy to organize a class and collaboratively work on projects and assignments with students. The teacher has always access to the student notebooks which makes it easy to track progress and assist the students when encountering problems.

UiO recently set-up a service to host and distribute notebooks for teachers and students at https://jupyterhub.uio.no/ (Jupyterhub, 2022). The UiO hub is free of charge but lacks several features compared to Cocalc.com. These include the option to host different terms or courses and collaborate online with a student. Thus, files have to be sent forth and back between student and teacher. There is also no option for grading course work. However, we have done this in Canvas anyway and the benefits of online collaboration dimmish a bit after the pandemic.

We copied and ran our projects on jupyterhub.uio.no. We have not yet tested to share these projects and assignments with students. However, it seems the jupyterhub.uio.no will be sufficient for our purpose and might replace Cocalc.com.

5 CONCLUSION

CoCalc provides a full-feature online environment to host, assign, and collaboratively work on student projects. It seems specifically suited to teach coding, data processing and analysis and applying open-source numerical and statistical models.

With on-demand licence fees of about 3$ per month and student costs are low considering that no local set-up, hosting, computing resources are necessary. We found CoCalc to be a well-suited platform to provide interactive and exploratory learning to students in Geosciences and related fields. CoCalc provides everything needed from computing resources over hosting to tracking, grading and communication with students. All this for a relatively low fee.

However, alternatives exist now at UiO with jupyterhub.uio.no and Canvas. These tools might act as a free alternative, but lack some of the advanced features of CoCalc.

6 ACKNOWLEDGMENTS

We would like to thank the iEarth Seed project for financial support for CoCalc licences.

REFERENCES

Cocalc, 2022, https://about.cocalc.com/, accessed 30.08.2022.

Jupyterhub, 2022, https://www.uio.no/tjenester/it/utdanning/jupyter/index.html, accessed 30.08.2022